

Coating Performance in Duluth Superior Harbor—Part 2

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Nine coatings were evaluated for corrosion protection of carbon steel coupons and I-beams around Duluth Superior Harbor after 46 and 35 months, respectively. Coupons were intentionally scribed to metal before exposure. Part 1 (September 2012 MP) described the coatings used and the locations of coupons and I-beams. Part 2 discusses the results of the evaluation.

AMA 2012107080

ixteen miles (26 km) of carbon steel (CS) sheet piling (12-mm thick ASTM A3281 cold rolled) used for docks, bridges, and bulkheads in the Duluth Superior Harbor (DSH) in Minnesota and Wisconsin are corroding at an accelerated rate of 3 mm/y or higher. The corroded pilings have an orange rusty appearance characterized by tubercles (i.e., corrosion products and deposits covering areas of localized corrosion). Barrier coatings provide one option for protection of extensive structures in fresh water, and nine coatings were evaluated for corrosion protection of CS coupons and I-beams around DSH after 46 and 35 months, respectively. Part 1 (September 2012 MP) described the coatings used and the locations of coupons and I-beams. Part 2 discusses the results of the evaluation.

Products

The following coatings were selected for this evaluation:

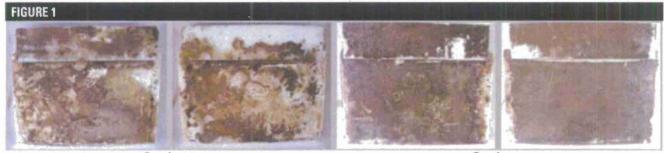
- 1 Aquapure HR*
- 2 Chevron Phillips TZ9043[†]
- 3 Standard epoxy
- 4 Humidur ML[†]
- 5 Wasser MC-zinc/MC-tar[†]
- 6 Sherwin-Williams Fast clad ERt
- 7 Poly-Spec LPE 5100[†]
- 8 Coal tar epoxy
- 9 Zinc-rich primer VZ108/V766

These products are identified throughout the article by number.

Coupons

There were no corrosion products or tubercles on any of the painted coupon surfaces like those that covered areas of localized corrosion on unprotected piling surfaces. The outward-facing coated surfaces were colonized with zebra mussels and a freshwater sponge. Zebra mus-

Trade name.



Coating 1

(Side A)

(Side B)

U.S. Coast Guard Celi B White two-part solvent-free polyamine epoxy Total exposure time 46 months

Observations Few byssal threads still attached Both sides covered in sponge material Top layer of coating peeling in places Corrosion evident in scribe (artificial defect) Muddy coating on surface

Coating 1 coupons.

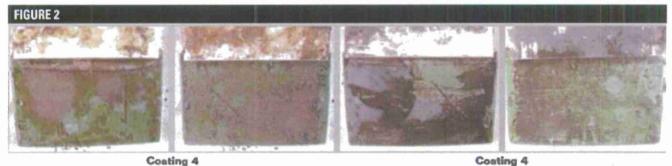
Coating 1

(Side A)

(Side B)

U.S. Coast Guard Cell C White two-part solvent-free polyamine epoxy Total exposure time 46 months

Observations Few byssal threads still attached Algae growing on one side of coupon Top layer of coating peeling from scribe Corrosion evident in scribe (artificial defect) Muddy coating on surface



(Side A)

(Side B)

U.S. Coast Guard Cell B Green two-part solvent-free polyamine epoxy Total exposure time 46 months

Observations Few byssal threads still attached Coating appears intact even in scribe area Corrosion evident in scribe Muddy coating on surface

Coating 4 coupons.

(Side A)

(Side B)

U.S. Coast Guard Cell C Green two-part solvent-free polyamine epoxy Total exposure time 46 months

Observations Few byssal threads still attached Coating appears intact even in scribe area Corrosion evident in scribe Muddy coating on surface except where silicone caulk used to attach Teflon holder

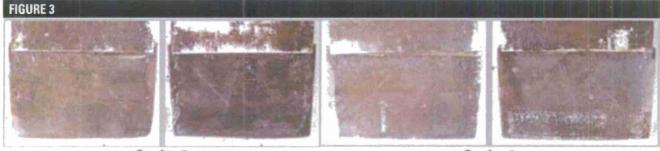
to accommodate the shipping container of Coating 1 was peeling from the scribe. size. Algae colonized the backside. Both Coatings 4, 5, 6, 7, and 9 remained intact sides were covered in a thin film of mud. and there were no indications of delami-There were no indications of coating nation even in the scribe area. Figures 1 degradation caused by the fouling. Local-through 4 present descriptions and obserized corrosion on the coupons was limited

sels were removed prior to digital imaging to the intentional scribe area. The topcoat vations.

I-Beams

Table 1 summarizes I-beam coating performance after exposure.

The topcoat of Coating 1 delaminated and peeled from the surface of the I-beam (Figure 5).



Coating 5

(Side A)

(Side B)

U.S. Coast Guard Cell C
Red urethane micaceous iron oxides
and refined coal tar
Total exposure time 46 months

Observations
Few byssal threads still attached
Some algse on coating surface
Coating appears intact even in scribe area
Corrosion evident in scribe
Muddy coating on surface

Coatings 5 and 9 coupons.

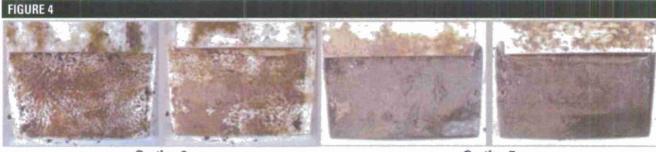
Coating 9

(Side A)

(Side B)

U.S. Coast Guard Cell C Blue/grey zinc primer/vinyl copolymers Total exposure time 46 months

Observations
Few byssal threads still attached
Some algae on coating surface
Coating appears intact even in scribe area
Corrosion evident in scribe
Muddy coating on surface



Coating 6

(Side A)

(Side B)

U.S. Coast Guard Cell B White smine epoxy (one cost) Total exposure time 46 months

Observations
Few byssal threads still attached
Coating appears intact even in scribe area
Coating lumpy and thick
Corrosion evident in scribe
Muddy coating on surface

Coatings 6 and 7 coupons.

Coating 7

(Side A)

(Side B)

U.S. Coast Guard Ceil C
Black polysulfide modified epoxy novolac
Total exposure time 46 months

Observations
Few byssel threads still attached
Some algae on coating surface
Coating appears intact even in scribe area
Corrosion evident in scribe
Muddy coating on surface

The-I beams were not scribed so the intentional defect was not necessary to initiate the delamination. The base coat remained intact and no localized corrosion was obvious. Coating 7 peeled from the surface in large sections, exposing uncoated steel with corrosion and tubercles (Figure 6).

All other coatings performed adequately. Chips along the edges of the I-beams may have occurred during transport.

Conclusions

Over a three- to four-year period, coatings prevented the formation of tubercles and localized corrosion on CS surfaces. Coating performance varied among the products and two products (Coatings 1 and 7) failed due to peeling. None of the coatings protected the substratum at an intentional defect.

Details showing all coating results are available from the authors.

Reference

 ASTM Standard A328/A328M-07, "Standard Specification for Steel Sheet Piling" (West Conshohocken, PA: ASTM International, 2007).

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Coating performance after exposure						
Product/Chemistry	Pass/Fail	Description				
1—white two-part solvent-free polyamine epoxy	Fail	Delamination, blistering, peeling				
2—light green/white two-part epoxy	Pass	Thick, uneven, intact, chips				
3—grey two-part polyamide epoxy/ zinc primer	Pass	Thick, smooth, intact, chips				
4—dark green two-part polyamine epoxy	Pass	Thick, lumpy, intact, chips				
5—red urethane micaceous iron oxides/refined coal tar	Pass	Thin, intact, fingerprints, chips				
6—white amine epoxy (one coat)	Pass	Thick, lumpy, intact, chips				
7—black polysulfide modified epoxy novolac	Fail	Broken, peeling, corrosion				
8—black two-part coal tar polyamide epoxy	Pass	Thin, smooth, intact, few chips				
9—blue/grey zinc primer/vinyl copolymers	Pass	Thin, rough, intact, chips				



Coating 1 shown on the I-beams.



Coating 7 shown on the I-beams.

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

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	REPORT DATE (DD-MM-YYYY) 2. REPORT TYPE 14-11-2012 Journal Article				3. DATES COVERED (From - To)		
4. TITLE AND SU	JBTITLE				5a. COI	NTRACT NUMBER	
Coating Performance in Duluth Superior Harbor - Part 2							
	5b		5b. GR	5b. GRANT NUMBER			
	5c. PR				5c. PRC	OGRAM ELEMENT NUMBER	
						W56MES00404548	
6. AUTHOR(S)	E AUTHORIE)					PROJECT NUMBER	
Richard I. Ray and Brenda Little					di moses nomen		
5e. T/				5e. TAS	SK NUMBER		
	Es Ma				E4 W/O	RK UNIT NUMBER	
bt. Wo				31. WO	73-9776-00-5		
		ON NAME(S) A	ND ADDRESS(ES)			8. PERFORMING ORGANIZATION REPORT NUMBER	
Naval Research Laboratory						NRL/JA/733012-1384	
Oceanography Division Stennis Space Center, MS 39529-5004					11113/3111/330 12 1301		
Stellins Space C	enter, Mb 55	329-3004					
9. SPONSORING	/MONITORING	AGENCY NAN	IE(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S)	
US Army Engineer District Detroit						Army	
PO Box 1027							
Detroit, MI 48231-1027						11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT							
Approved for public release, distribution is unlimited.							
Approved for paone release, distribution is diminited.							
13. SUPPLEMENTARY NOTES							
14. ABSTRACT							
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15, SUBJECT TERMS							
carbon steel, coatings, evaluation, corrosion, protection							
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16, SECURITY CLASSIFICATION OF: 17. LIMITATION OF 1B. NUMBER 19a. NAME OF RESPONSIBLE PERSON						ME OF RESPONSIBLE PERSON	
	APCTRACT		Richard Ray				
Unclassified U	Unclassified	Unclassified	UL	4	19b, TELEPHONE NUMBER (Include area code) (228) 688-4690		